Business & Enterprise Systems

Integrity - Service - Excellence

Introduction to the Developmental Test & Evaluation (DT&E) Process

30 October 2015

Training Objective

Provide introductory level instruction to all Program Management Office (PMO) and other stakeholders involved in the Developmental Test and Evaluation (DT&E) Process

Agenda

- Basic Fundamentals of Testing
- Purpose of DT&E
- Overview/Assumptions of the Developmental Test & Evaluation (DT&E) Process
- Initial Integrated Test Design (IITD)
- Component Validation and Integration (CV&I)
- Qualification Test and Evaluation (QT&E)
- Open Discussion

Basic Fundamentals of Testing: Testing Objectives

- **The goal of testing is to discover errors**
  - **Testing is the process of trying to discover HIGH RISK errors or defects in a system**
- **Testing hunts errors**
  - **Tests run may trigger failures that expose defects**
  - **Tests run may demonstrate the absence of serious defects**
  - **Focus narrowly on a few high risk features to find the most bugs in the time available**
  - **Provides relevant (credible/realistic) information to development team**
  - **Uncover defects so serious they would block premature product release**
  - **Assesses conformance to specification (requirements)**

Basic Fundamentals of Testing:
Demonstrating Program Effectiveness

- Testing cannot show the absence of defects, it can only show that software errors are present
- Complete testing is impossible for several reasons:
  - We can't test the following:
    - All the inputs to the program
    - All the combinations of inputs to the program
    - All the paths throughout the program
    - For all of the other potential failures, such as those caused by user interface design errors or incomplete requirements analyses

Basic Fundamentals of Testing:
Basic Forms of Testing

U.S. AIR FORCE

Verification:

Peers, System Engineers, and Developers

- **Evaluation of a System or Component to determine whether or not they meet documented requirements**
- **Did we build the product Right?**
- **Includes human and computer testing**

Validation:

Test Organization, Users

- **Evaluation of a System or Component in its intended environment to determine whether it performs its intended functions**
- **Demonstrates suitability & effectiveness of the System**
- **Did we build the right product?**
- **Execution of System**

t everything is testable. Other forms of verification and validation incl
ection, peer reviews, auditing, data sampling, etc.

U.S. AIR FORCE

Basic Fundamentals of Testing: Testing Principles

- Tests must be traceable to documented requirements
- Tests should be thoroughly planned before testing begins
- Pareto Principle applies to software testing (20% of problems cause 80% of rework cost)
- Testing should begin “In the Small” and progress towards testing “In the Large” (i.e., testing progresses from component to integrated system level testing)
- Exhaustive testing is not possible
- To be most effective, testing should be conducted as a collaborative effort across the PMO, LDTO and Development Team

Basic Fundamentals of Testing:
Software Testing Performance (1 of 2)

- **Software testing is performed according to defined processes**
  - **Testing criteria are developed and reviewed with the customer and end users**
  - **Effective methods are selected and used to test the software**
  - **The adequacy of testing is determined based on:**
    - **The level of testing performed (e.g., component testing, integration testing, system testing and acceptance testing)**
    - **The test strategy selected: functional, structural or statistical**
    - **The test coverage to be achieved: statement coverage, path coverage and branch coverage**
    - **Incorporating results of risk analysis (Capabilities Risk-Based Assessment)**
  - **For each level of software testing, test readiness criteria are established**

Basic Fundamentals of Testing:
Software Testing Performance (2 of 2)

- The test plan, test description, test procedures and the test cases undergo peer review before they are considered ready for use
- The test plans, test description, test procedures and test cases are managed and placed under CM control
- Test plans, test descriptions, test procedures and its cases are appropriately changed whenever the allocated requirements change
- Regression testing is performed, as appropriate, at each test level (regardless of whenever the software is being tested or if its environment changes)
  - Break-fix regression testing
  - System regression testing

What is the Purpose of DT&E?

- The real purpose of DT&E is to find and fix deficiencies, problems, or erroneous code at the earliest possible time in the lifecycle of a program or project
  - DT&E supports this purpose by integrating its 3 component integrated phases:
    - (1) Initial Integrated Test Design (IITD)
    - (2) Component Validation and Integration (CV&I)
    - (3) Qualification Test and Evaluation (QT&E)
  - DT&E evaluates the design, quality, performance, functionality, security, interoperability, supportability, usability and maturity of a system or capability in an operationally relevant environment

Overview/Assumptions

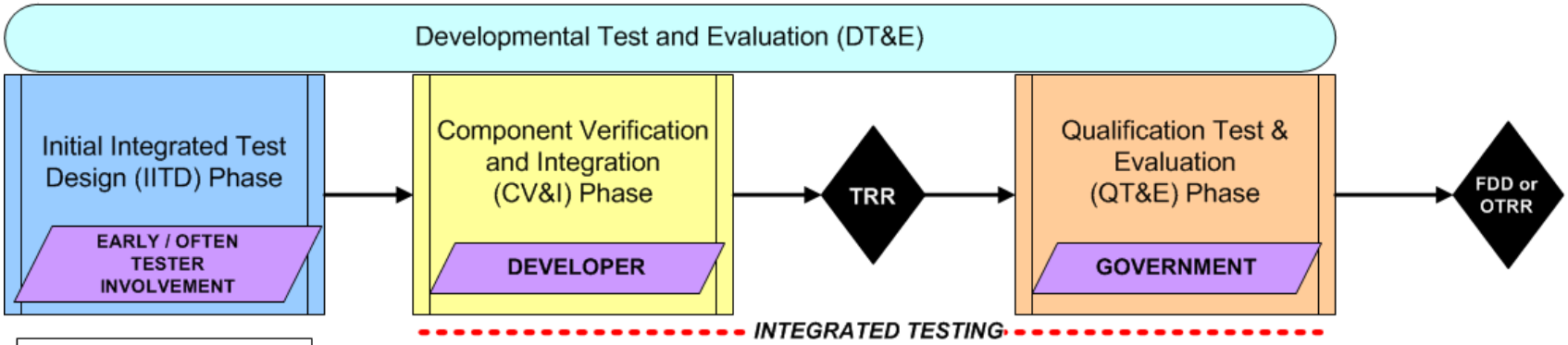
- **Assumptions**
  - **Defense Business Systems (DBS) focused**
  - **Process and concepts can be tailored to meet new acquisition and sustainment programs**
  - **Does NOT address specific environments or infrastructure**
  - **Engrained in current BEP Process Directory (BPD)/ current best practices**
  - **DT&E follows guidance and procedures outlined in the BES BPD Development Test and Evaluation (DT&E) Guide.**
- **In use by all DBS and services for which the Test Branch (AFLCMC/HNIZ) is the appointed Lead Developmental Test and Evaluation Organization (LDTO) and also for other systems for which Gunter is not designated as LDTO**
- **Director, Operational Test & Evaluation (DOT&E) and Deputy Assistant Secretary of Defense (DASD), Developmental Test and Evaluation (DT&E) recognized and accepted processes**

U.S. AIR FORCE

DT&E Overview

Developmental Test & Evaluation (DT&E) Process Overview

Version 8.1



ITT Established/Chartered
TIPTs Formed
Requirements Analysis
Test Planning
Test Documentation

CV&I

Performed by the developing agency with government participation

Demonstrates that individual components and assembled components are developed IAW approved designs and function properly to meet documented requirements. CV&I includes the following test segments:

- Individual Component Verification (ICV)
- Component Integration Test (CIT)
- Data Management Evaluation (DME)
- Requirements Operability Test (ROT)
- Performance Evaluation Test (PET)
- Cybersecurity Evaluation (CSE)
- Regression Test (RT)
- System Integration Test (SIT)
- User Evaluation Test (UET)

QT&E

Performed by the Lead Developmental Test & Evaluation Organization (LDTO)

Validates the product integrates into the intended environment, meets documented functional, non-functional, and cybersecurity assurance requirements and performance standards. QT&E includes the following test segments:

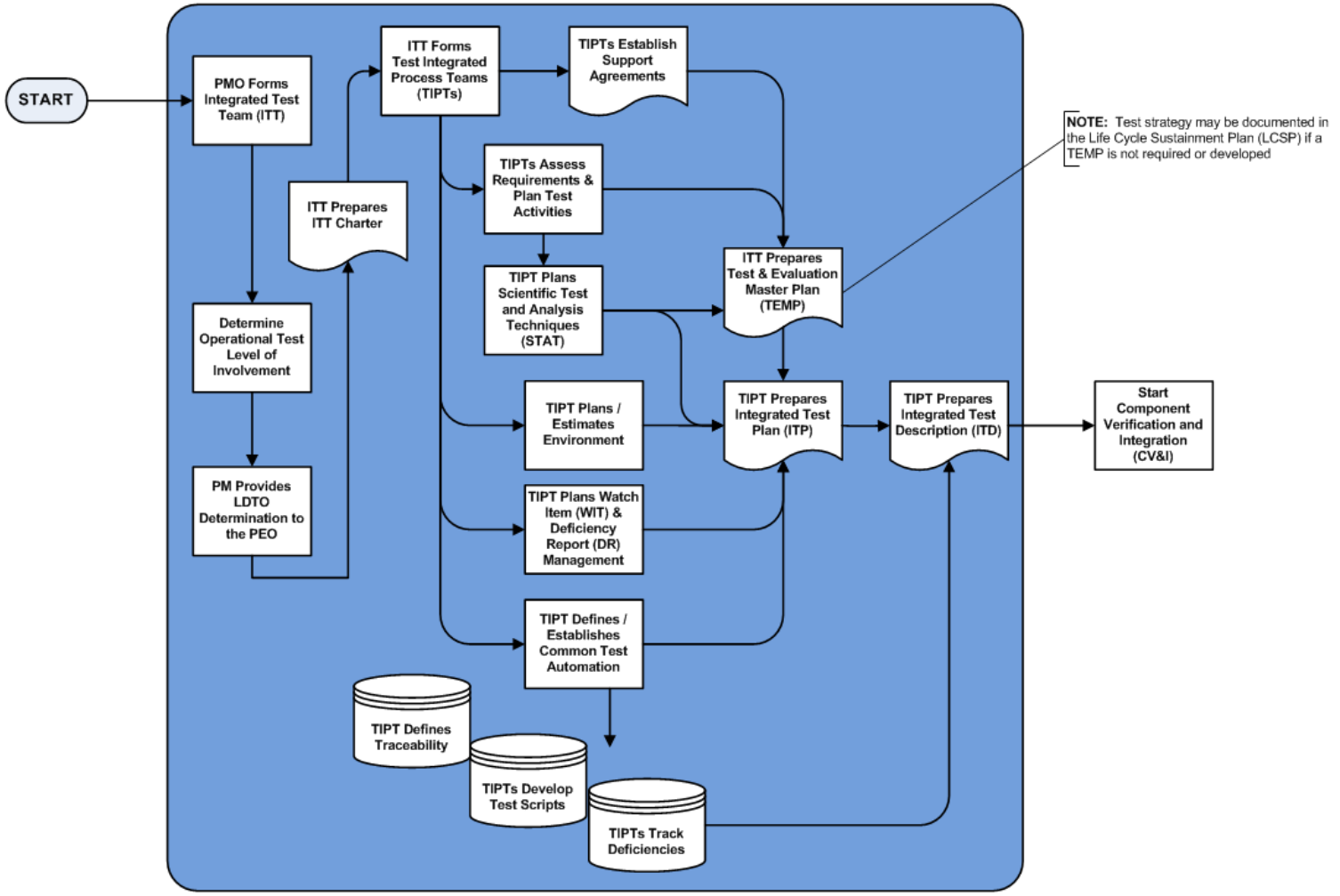
- System Integration Test (SIT)
- Data Management Evaluation (DME)
- System Operability Evaluation (SOE)
- Performance Evaluation Test (PET)
- Cybersecurity Evaluation (CSE)
- Regression Test (RT)
- User Evaluation Test (UET)

U.S. AIR FORCE

Initial Integrated Test Design (IITD) Phase

DT&E Initial Integrated Test Design (IITD) Phase

Version 8.1


START
PMO Forms Integrated Test Team (ITT)
ITT Forms Test Integrated Process Teams (TIPTs)
TIPTs Establish Support Agreements
TIPTs Assess Requirements & Plan Test Activities
ITT Prepares ITT Charter
TIPT Plans Scientific Test and Analysis Techniques (STAT)
ITT Prepares Test & Evaluation Master Plan (TEMP)
NOTE: Test strategy may be documented in the Life Cycle Sustainment Plan (LCSP) if a TEMP is not required or developed
Determine Operational Test Level of Involvement
TIPT Plans / Estimates Environment
TIPT Prepares Integrated Test Plan (ITP)
TIPT Prepares Integrated Test Description (ITD)
Start Component Verification and Integration (CV&I)
PM Provides LDTO Determination to the PEO
TIPT Plans Watch Item (WIT) & Deficiency Report (DR) Management
TIPT Defines / Establishes Common Test Automation
TIPT Defines Traceability
TIPTs Develop Test Scripts
TIPTs Track Deficiencies

IITD – Objectives

- IITD kicks-off test strategy and planning between the Developer and Government
- The initial outcome of IITD yields:
  - Requirements that are <u>testable</u> and which possess the following qualities:
    - Cost Effective
    - Unambiguous- everyone has the same understanding
    - Traceable to documented requirements
    - Reliable cost and schedule estimates

IITD – Early & Often Tester Involvement

- **IITD begins early in the acquisition life cycle; involvement of T&E personnel is critical as test planning will be conducted throughout a program's life cycle**
- **Program Mangers (PMs) will ensure T&E personnel are involved early in the system's life cycle starting with developing and defining requirements, acquisition strategy development, program tailoring activities, and development of program schedule; initial products include:**
  - **Requirements Traceability Matrix**
  - **Requirements Tests**
  - **Tailoring Worksheet (Test Planning)**
  - **Formal Integrated Test Team (ITT) Charter**
  - **Test and Evaluation Master Plan (TEMP)**

IITD – Integrated Test Team (ITT)

- **The Integrated Test Team (ITT) is a cross-functional chartered team of empowered representatives/organizations established to assist the acquisition community with all aspects of T&E planning and execution**
  - **If the Air Force Operational Test & Evaluation Center (AFOTEC) declines participation, the ITT should determine if Major Command (MAJCOM) Operational Testing (OT) is required**
  - **The LDTO will co-chair the ITT as the senior test agency when there is no operational test organization participating**
  - **The ITT will assist the PM in creating Integrated Master Schedules**
- **The ITT will ensure development of the Test & Evaluation Strategy (TES), TEMP, Integrated Test Plan (ITP), and other T&E related documentation**

IITD – Test Integrated Product Teams (TIPTs)

- **Test Integrated Product Teams (TIPTs)**
  - **TIPTs are any temporary group, formed by the ITT, consisting of test and other subject matter experts who are focused on specific planning, issues or problems**
  - **Example of TIPTs can include:**
    - **Develop Use Case Scenarios**
    - **Develop Test Cases/Scripts**
    - **Any other specific T&E planning tasks or work defined test issues**

IITD – Requirements Analysis (1 of 3)

- **Requirements Analysis**
  - **T&E personnel will participate in all program activities that support the development of requirements, configurations, or blueprinting activities**
  - **T&E personnel will assist the PM by ensuring that requirements/configurations are complete, clear, concise, and testable and can be validated**
  - **Requirements, as identified from operational need, take the form of operational, functional capability and technical requirements and are derived from the Concept of Operations (CONOPS), Capabilities Description Document (CDD), Business Case, System Requirements Documents (SRD), etc.**

IITD – Requirements Analysis (2 of 3)

U.S. AIR FORCE

- **Program Management Office (PMO), LDTO and functional community collaboration**
  - **Collaborate to perform a Capabilities Risk-Based Assessment to provide the PM the ability to access/evaluate the risk to the program if enough time has not been incorporated to schedule to fully test the capability**
- **Technical Reviews relevant to T&E**
  - **System Requirements Review Procedure (SRR) – multi-disciplined technical review to ensure that the system under review can proceed. The review will show that all system requirements and performance requirements are defined and are consistent with cost (program budget), risk, and other system constraints. Generally, this review assesses the system requirements as captured in the system specification, and ensures that the system requirements are consistent with the preferred system**

IITD – Requirements Analysis (3 of 3)

- **Technical Reviews relevant to T&E**
  - **System Functional Review (SFR) – multi-disciplined technical review to ensure that the system under review can proceed into preliminary design. It should be demonstrated at the review that all system requirements and functional performance requirements are defined and are consistent with cost (program budget), risk, and other system constraints. Generally, this review assesses the system functional requirements as captured in the system specifications, and ensures that the required system performance is fully decomposed to lower level sub-system functionality**

IITD – Test Planning

- **Test Planning**
  - **The TEMP/Life Cycle Management Plan (LCMP) supports the TES which describes how operational capability requirements will be tested in support of the program's acquisition strategy**
  - **The TEMP identifies the necessary developmental and operational test activities. Furthermore, the TEMP relates program schedule, test management strategy, structure and required resources to the:**
    - **Critical Operational issues (COIs)**
    - **Critical Technical Parameters**
    - **Requirements Objectives and Thresholds**
    - **Milestone decision points**

IITD – Test Documentation

- **Additional test documentation includes:**
  - **Integrated Test Plan (ITP) – Establishes scope of DT&E activities and integrates both developer & government test approaches/activities into a single overarching plan covering all DT&E events**
  - **Integrated Test Description (ITD) – Establishes the scope of DT&E activities of the program to a SPECIFIC release**
  - **Test scenarios, case, and scripts guide T&E activities by defining step-by-step instructions to effectively evaluate the requirements of a release**
  - **Watch Item/Deficiency Review Boards (WIT/DRBs) are established to manage PRs and deficiencies identified during T&E activities**

IITD – Exit Criteria

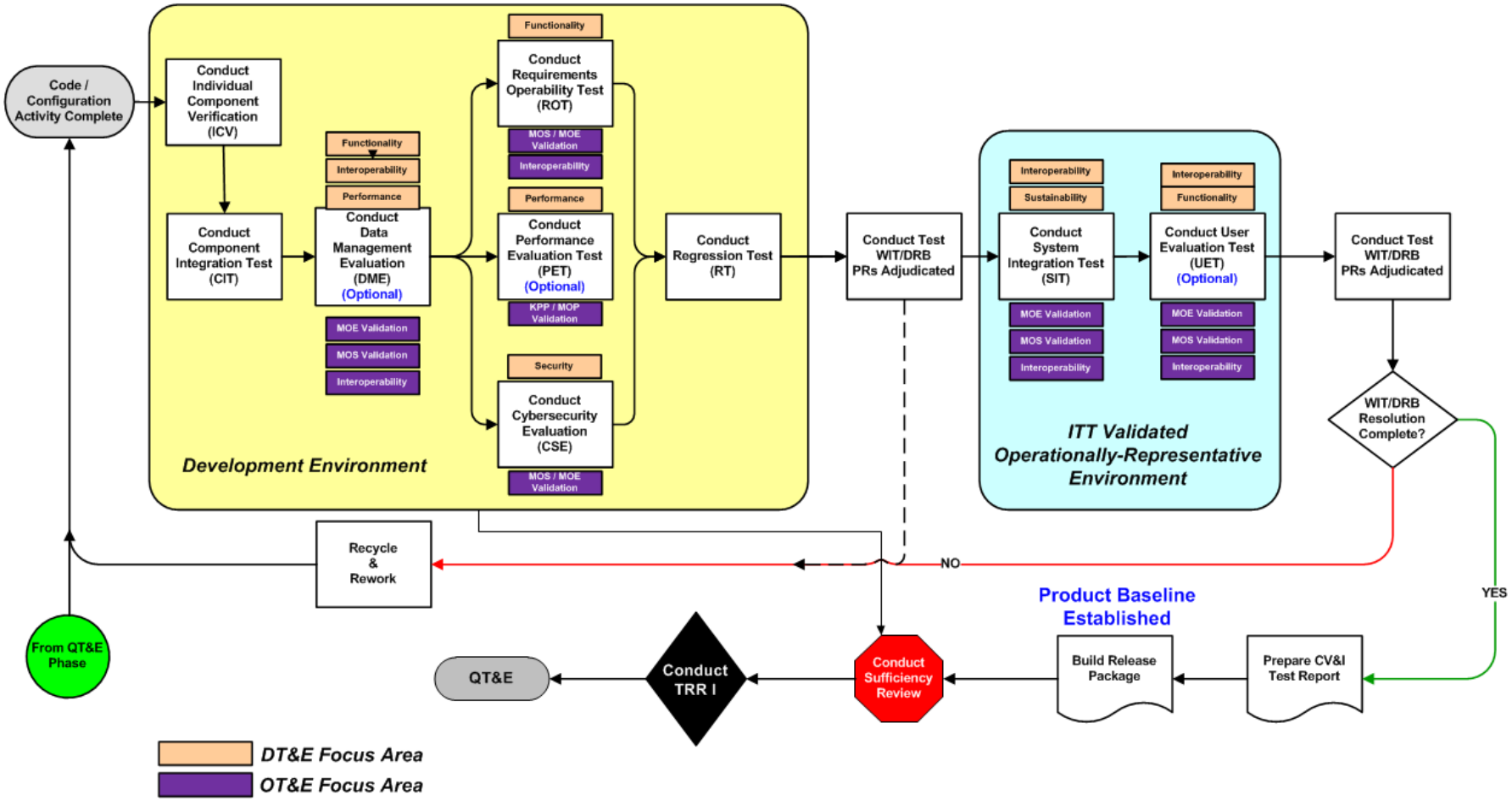
- **IITD represents the planning phase and activities of the entire DT&E process**
  - **Formation of a chartered ITT and subsequent TIPTs**
  - **Completion of requirements, capabilities assessments, plan test activities and establish test management process (PRs/WIT)**
  - **Preparation of TES & TEMP**
  - **Completion of Integrated Test Plan (ITP)**
  - **Completion of Integrated Test Description (ITD)**

Component Validation & Integration (CV&I) Test Phase

U.S. AIR FORCE

DT&E Component Verification & Integration (CV&I) Phase

Version 8.1



CV&I – Objectives

- CV&I objectives and activities include:
  - Finalization of draft test scripts and plans (ITP, TEMP)
  - Code and configure components in the development environment
  - Component validation testing in development environment
  - Led by developing agency/integrator with government participation
  - CV&I composed of following test segments: ICV, CIT, DM, ROT, PET, CSE, SIT, UET
  - Test the complete system:
    - Test components:
      - One at a time, then combined
      - Regression testing
  - Generate the CV&I portion of the Integrated Test Report (ITR)
  - Prepare for Test Readiness Review 1 (TRR 1)

CV&I – Individual Component Validation (ICV)

- **Individual Component Validation (ICV)**
  - **Often called Unit Testing / String Testing / Code Walk-Through**
  - **Validates the <u>each individual component</u> is developed IAW approved designs and functions properly to meet specified requirements**

CV&I – Component Integration Test (CIT)

- **Component Integration Test (CIT)**
  - **Often called Assembly Test / Functional Integration Test**
  - **Validates that completed components can be integrated into a complete system IAW approved designs and specified requirements**

CV&I – Data Management (DM)

- **Data Management (DM)**
  - **Consists of Extract, Transform, and Load (ETL) data from one system for use in another, usually for the purpose of application interoperability or system modernization**
  - **May consist of data migration, data conversion, data validation**

CV&I – Requirements Operability Test (ROT)

- **Requirements Operability Test (ROT)**
  - **Often called Functional Testing / Function and System Testing**
  - **Verifies, from a functional perspective, that the integrated system functions properly and meets specified requirements**
  - **Government observation; integrated and collaborative testing**

CV&I – Performance Evaluation Test (PET)

- **Performance Evaluation Test (PET)**
  - **Includes techniques like bandwidth analysis, load and stress testing, and performance analysis to ensure system performs IAW specified requirements and approved designs**

CV&I – Cybersecurity Evaluation (CSE)

- **Cybersecurity Evaluation (CSE)**
  - **Conducted by PMO and Information System Security Managers**
  - **Evaluation of information-related risks; assessment of network security policies, identification and authentication, access controls, auditing, and the confidentiality, integrity, and availability of data and their delivery systems**
  - **IAE may include application of Security Technical Implementation Guides (STIGs), Security Readiness Review (SRR) Scans and Security Control Validation**

CV&I – System Integration Test (SIT)

- System Integration Test (SIT)
  - Validates the integration of a system into an operationally-relevant environment (installation, removal, and back-up and recovery procedures).
  - CV&I SIT is conducted by the developing activity in an operationally-relevant environment, observed by the government

CV&I – User Evaluation Test (UET)

- **User Evaluation Test (UET)**
  - **Typically ad-hoc testing conducted by end-users of the system**
  - **Conducted to offer an early look at the maturity of the system and to evaluate the feasibility of the system to meet mission requirements.**

CV&I – Regression Testing

- **Regression Testing**
  - **Conducted throughout all CV&I segments**
  - **Verifies existing capabilities and functionality is not diminished or damaged by changes or enhancements introduced into a system**
  - **Also includes “break-fix” testing which verifies corrections implemented function to meet specified requirements**

CV&I Sufficiency Review

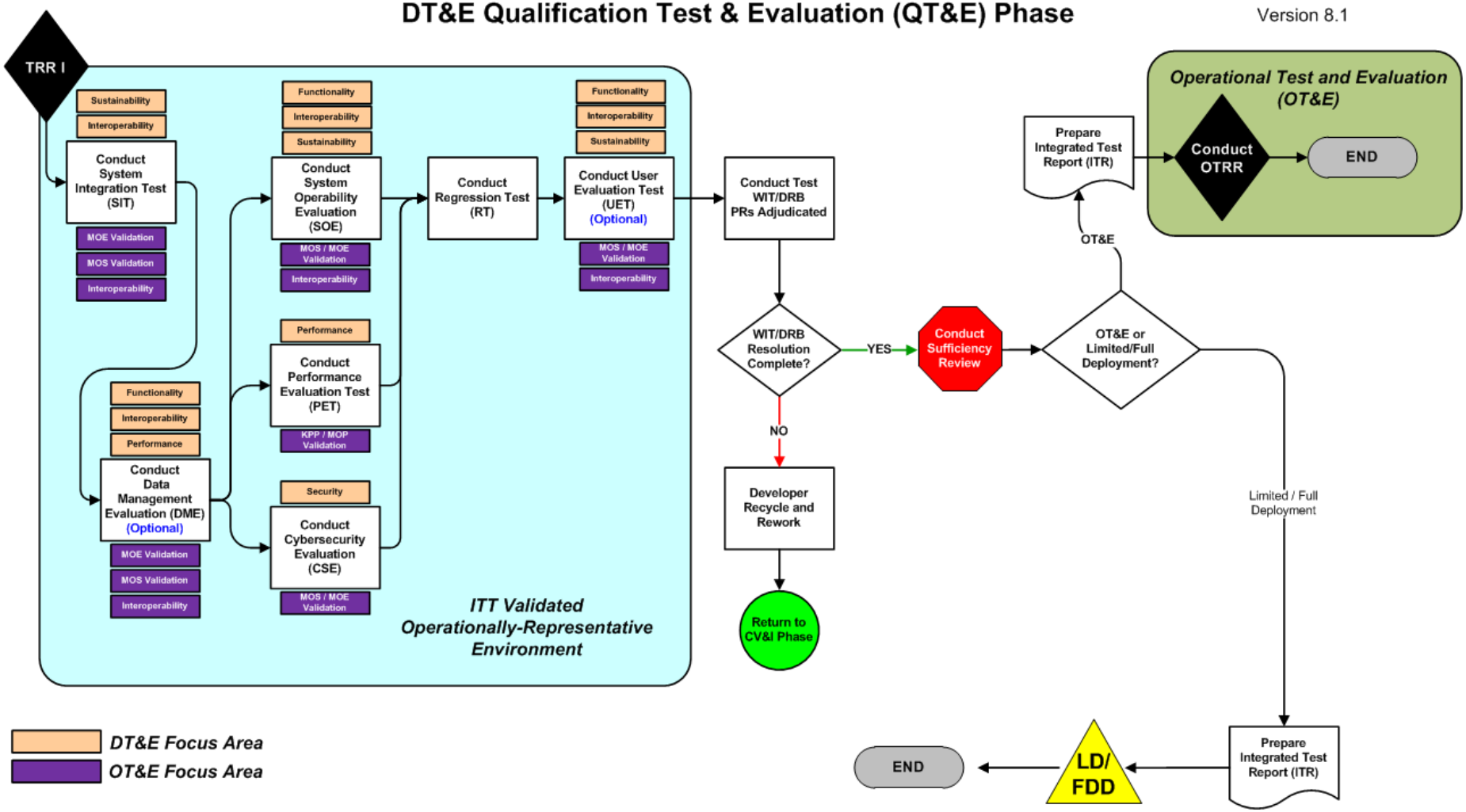
- Review conducted prior to Test Readiness Review I (TRR I)
  - Assessment that determines the sufficiency of CV&I test activities
  - Results of the review provides an engineering go/no-go recommendation and determination of system readiness to conduct TRR I

CV&I – Exit Criteria = TRR I

- **TRR I:**
  - **Conducted upon completion of CV&I**
  - **Chaired by Program Manager**
  - **Ensures satisfactory completion of TTR I entry and exit criteria**
    - **If the results of TRR I are favorable, the program enters the QT&E phase of DT&E**
    - **If the results of TRR I is to not to proceed into QT&E, the program returns to the appropriate point in CV&I test phase for resolution of problems**
    - **If agreement is not reached, elevate the issue up the engineering and program management chains of command**
  - **Meeting minutes placed under formal CM control**

Qualification Test & Evaluation (QT&E) Test Phase

U.S. AIR FORCE



Qualification Test and Evaluation (QT&E)

- **QT&E objectives:**
  - **Led by LDTO (Government)**
  - **Validates the product integrates into its intended environment, meets specified requirements IAW the approved design, meets performance standards, and validates the information assurance controls employed by the system meet DoD standards and policies**
  - **Performed in a government provided and managed operationally-representative environment**
  - **Supports Limited Deployment (LD) test activities in the production environment**
  - **Can also be supported by end-users (with oversight by the LDTO/PTO) to provide end-user input related to system maturity and its ability to meet operational mission requirements**
  - **Consists of the following segments: SIT, DM, SOE, PET, CSE, UET and SAT**

QT&E – System Integration Test (SIT)

- System Integration Testing (SIT)
  - Oversight provided by the LDTO; managed and conducted by Participating Test Organizations (PTOs)
  - Validation of the integration of the product into the QT&E (operationally-representative) environment (install, uninstall, and back-up/recovery procedures)

QT&E – Data Management (DM)

- **Data Management (DM)**
  - **Consists of Extract, Transform, and Load (ETL) data from one system for use in another, usually for the purpose of application interoperability or system modernization**
  - **May consist of data migration, data conversion, data validation**

QT&E – System Operability Evaluation (SOE)

- System Operability Evaluation (SOE)
  - Conducted by the LDTO and PTOs
  - Conducted in an operationally-representative environment
    - Validates the test environment (hardware and software)
    - Demonstrates security, interoperability, sustainability, supportability, and usability
  - Traceable scenario and script driven end-to-end qualification testing
  - Validates the integrated system functionality
  - Should include regression testing to validate that existing capabilities/functionality is neither diminished nor damaged by changes or enhancements introduced to a system

QT&E – Performance Evaluation Test (PET)

- Performance Evaluation Testing (PET)
- Oversight provided by the LDTO; managed and conducted by Participating Test Organizations (PTOs)
  - Includes techniques like bandwidth analysis, load and stress testing, performance analysis
  - PET during QT&E may be tailored, based on the results of similar tests conducted during CV&I

QT&E – Cybersecurity Evaluation (CSE)

- **Cybersecurity Evaluation (CSE)**
  - **Conducted by the PMO and Information System Security Managers**
  - **Evaluation of information-related risks; assessment of network security policies, identification and authentication, access controls, auditing, and the confidentiality, integrity, and availability of data and their delivery systems**
  - **CSE may include application STIGs, SRR Scans and Security Control Validation**

QT&E – User Evaluation Test (UET)

- **User Evaluation Test (UET)**
  - **Typically ad-hoc testing conducted by end-users of the system**
  - **Conducted to offer an early look at the maturity of the system and to evaluate the feasibility of the system to meet mission requirements**

QT&E – Limited Deployment (LD)

- LD begins when the Functional Sponsor and the Milestone Decision Authority (MDA) approves fielding the capability into an operational environment for:
  - System Acceptance Test (SAT), conducted during the QT&E Test Phase
  - Obtains confirmation that a system meets requirements; end users or subject matter experts provide such confirmation after they conduct a period of trial or acceptance test
  - Initial Operational Test and Evaluation (IOT&E) of the implementation and use of a major release at one or more selected operational sites
  - It provides the opportunity to observe the initial implementation and use of the system under actual operating conditions prior to the Full Deployment Decision (FDD)

QT&E – Regression Testing

- **Regression Testing**
  - **Conducted throughout all segments of QT&E**
  - **Validates existing capabilities and functionality is not diminished or damaged by changes or enhancements introduced into a system**
  - **Also includes “break-fix” testing which verifies corrections implemented function to meet specified requirements**

QT&E – Sufficiency Review

- **Review conducted prior to Test Readiness Review II (TRR II)**
  - **Assessment that determines IT&E progress and effectiveness at the QT&E mid-point the sufficiency of QT&E test activities**
  - **Results of the review provides an engineering go/no-go recommendation and determination of system readiness move into Operational Test and Evaluation (OT&E), Limited Deployment (LD) or Production**

QT&E – Exit Criteria (TRR II)

- **TRR II**
  - **Conducted at completion of QT&E**
  - **Chaired by Program Manager to signify that the main phase of QT&E is complete and the release is ready to move into LD test activities or into Operational Test and Evaluation**
    - **The LDTO and Program Test Manager (PTM) will assist the PM in preparing and conducting the TRR II**
  - **Systems forgoing LD and moving straight to full deployment do not require TRR II**

QT&E – System Acceptance Test (SAT)

- System Acceptance Test (SAT)
  - Conducted during the QT&E phase as part of Limited Deployment (LD)
  - Obtains confirmation that a system meets user requirements
  - End users or subject matter experts provide such confirmation after they conduct a period of trial or acceptance testing
- IOT&E is an additional component of LD after SAT to evaluate the implementation and use of a major release at one or more selected operational sites to provide the opportunity to observe the initial implementation and use of the system under actual operating conditions prior to the Full Deployment Decision (FDD)

Summary

- Basic Fundamentals of Testing
- Purpose of DT&E
- Overview/Assumptions of the Integrated Developmental Test & Evaluation (DT&E) Process
- Initial Integrated Test Design (IITD)
- Component Validation and Integration (CV&I)
- Qualification Test and Evaluation (QT&E)
- Open Discussion

Open Discussion

U.S. AIR FORCE

Recap and Feedback

- **Do you have any unanswered questions?**
- **Did we meet the objectives as stated?**
- **Don’t forget to request your CLPs!**
- **Please fill out a critique so we can improve this class for those who may attend in the future; written suggestions are very helpful**